Navy
Electromagnetic Environmental Effects (E3) / Spectrum Supportability (SS)

Joint Training Working Group (JTWG)

Navy Training Status

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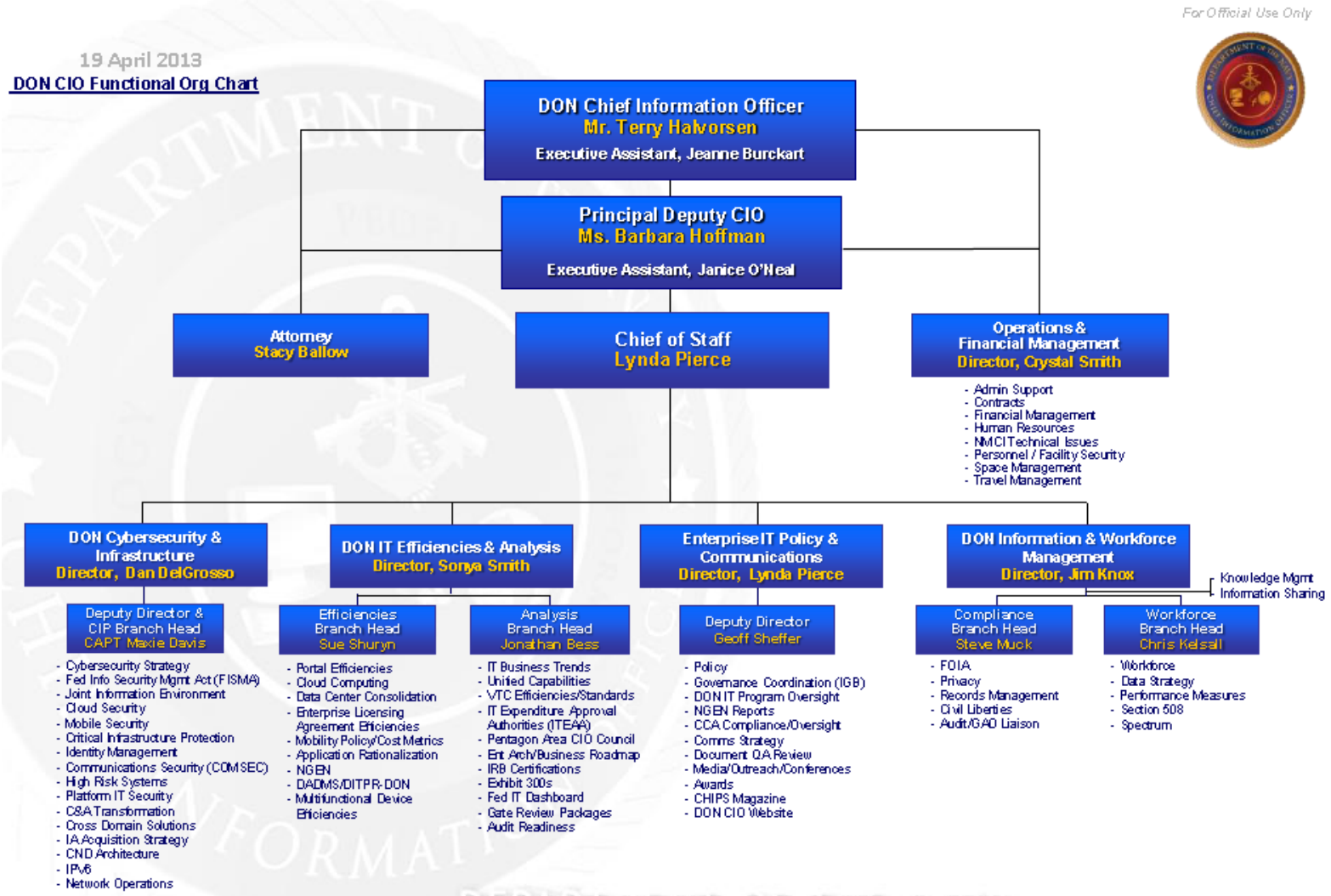
SPAWAR Systems Center ATLANTIC

Agenda

- Navy E3/SS Program
- Navy Plans, Policy, and Guidance
- Mission Focused Force
- E3/SM NTSP Accomplishments
- Navy Knowledge Online (NKO) eLearning
- Navy Acquisition Courses
- ACC Practice Center

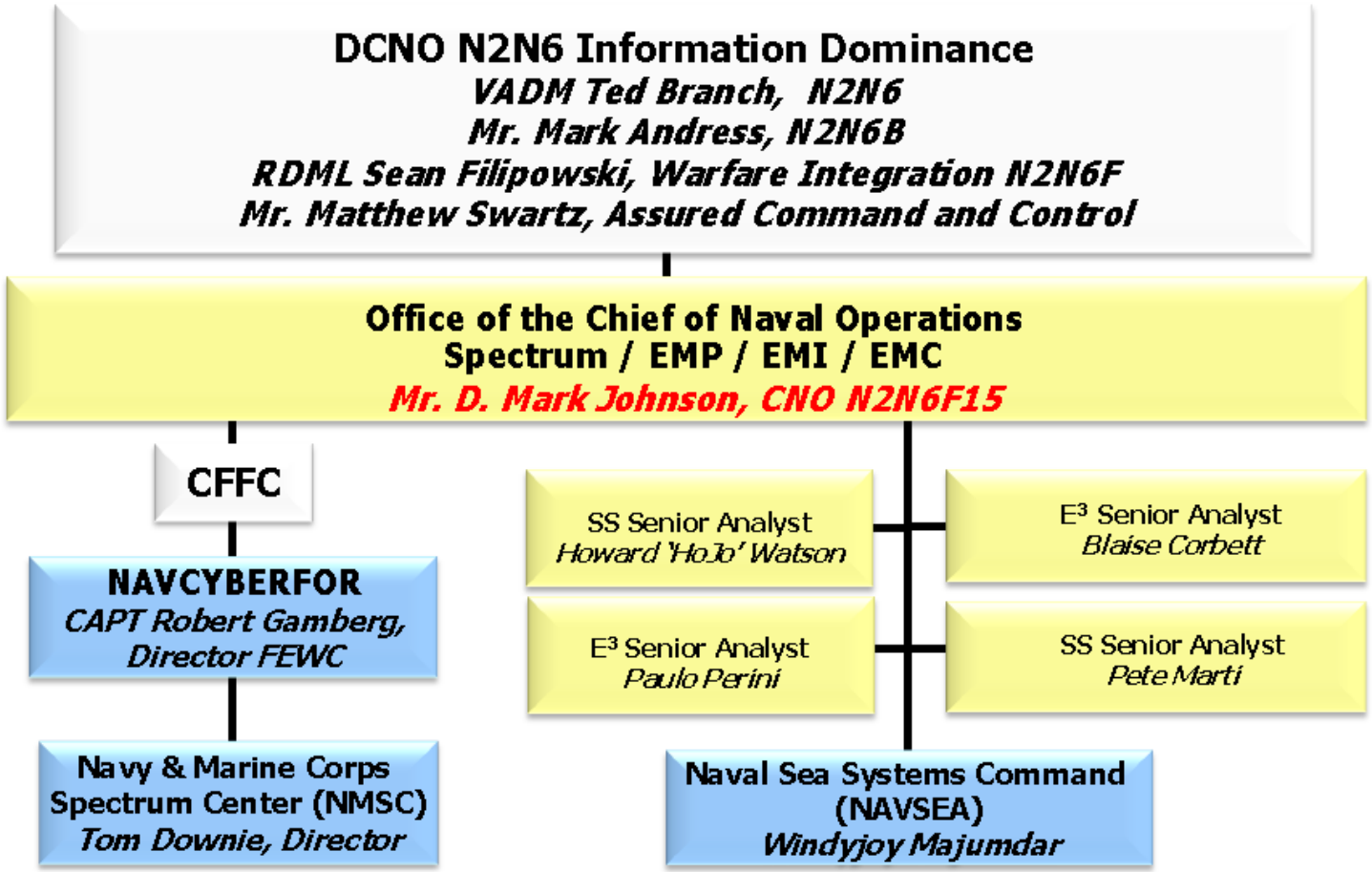
DON CIO Organization



USN E3/Spectrum Organization

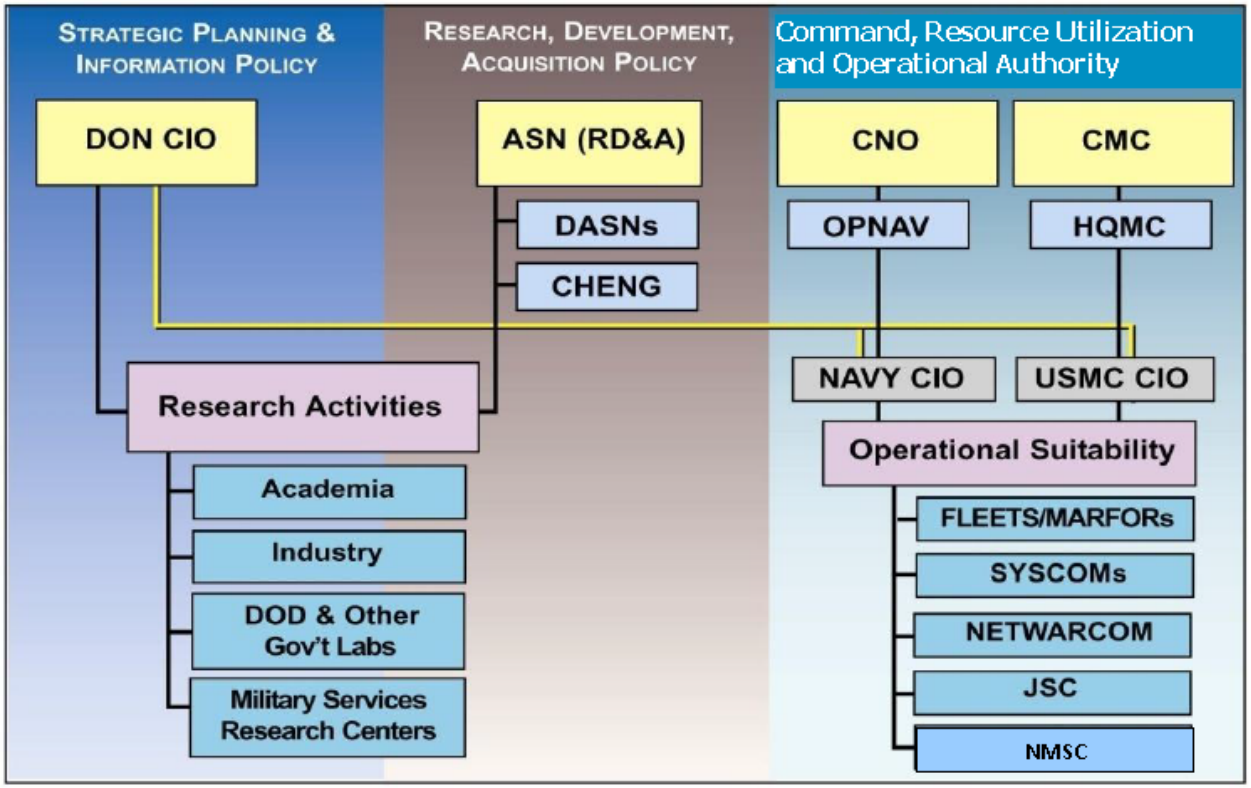
Warfighting First – Operate Forward – Be Ready

US Navy E³/Spectrum Organization



DON Spectrum Relationships

Department of the Navy Spectrum Relationships



CNO Plans, Policy, and Guidance

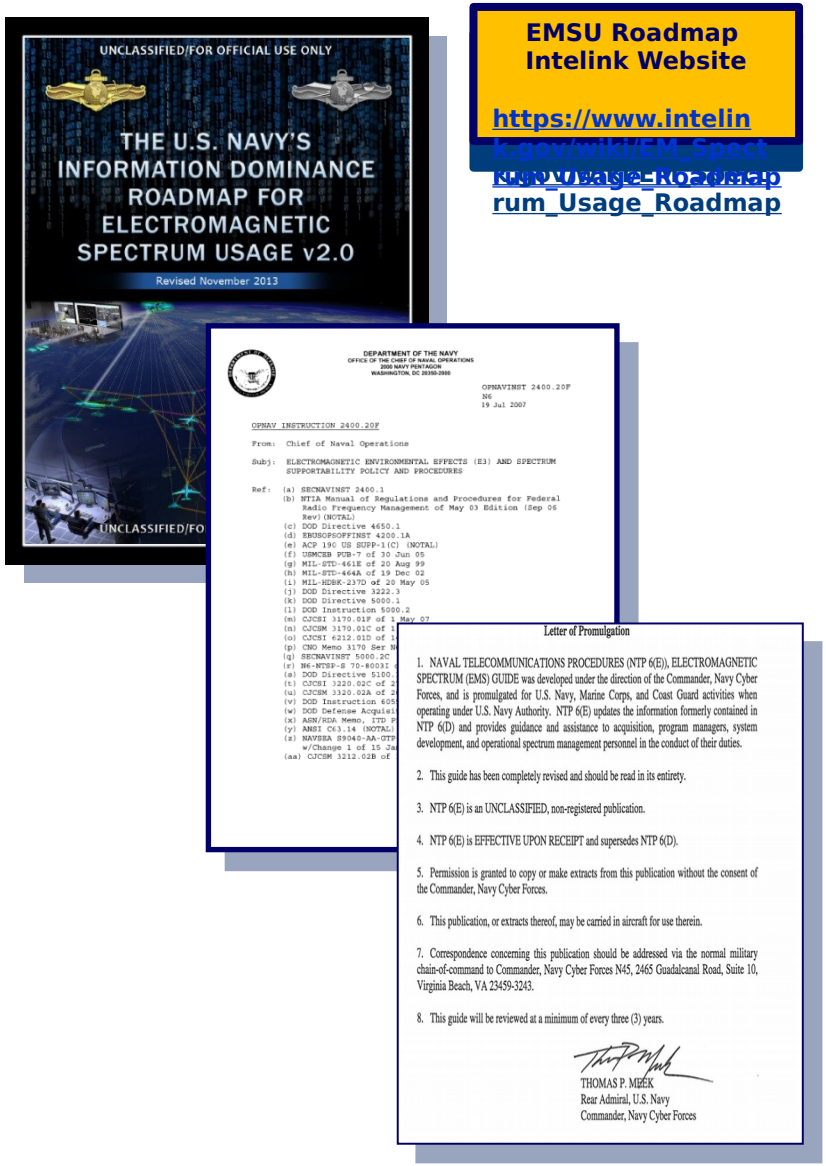
- **Electromagnetic Spectrum Usage (EMSU) Roadmap;**
  Updated November 2013
  - The roadmap identifies the capabilities required to enable the U.S. Navy to operate in the joint EMS environment during the 2014–2027 timeframe. The capabilities identified in this roadmap provide a coherent way ahead for the examination of doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF) solutions.

- **OPNAVINST 2400.20F; 7 Jul 2007, Rev (G) in Signature review**
  Electromagnetic Environmental Effects (E3) Policy and Procedures
  - Assigns responsibility for Spectrum Supportability, Spectrum Certification, Frequency Assignment and E3 within the Department of the Navy (DON) in consonance with policy established by the Secretary of the Navy
  - Provides the framework and details the requirement for implementing the Chief of Naval Operations (CNO) directed Electromagnetic Environment Effects (E3) and Spectrum Management (SM) training for all DON personnel

- **NTP6 (E); April 2011 Naval Telecommunications Procedures:**
  Navy Electromagnetic Spectrum (EMS) Guide

EMSU Roadmap Intelink Website

https://www.intelink.gov/wiki/EM_Spectrum_Usage_Roadmap


UNCLASSIFIED/FOR OFFICIAL USE ONLY
THE U.S. NAVY'S INFORMATION DOMINANCE ROADMAP FOR ELECTROMAGNETIC SPECTRUM USAGE v2.0
Revised November 2013
UNCLASSIFIED/FO
DEPARTMENT OF THE NAVY
OPNAVINST 2400.20F
N6
19 Jul 2007
OPNAV INSTRUCTION 2400.20F
From: Chief of Naval Operations
Subj: ELECTROMAGNETIC ENVIRONMENTAL EFFECTS (E3) AND SPECTRUM SUPPORTABILITY POLICY AND PROCEDURES
Ref: (a) SECNAVINST 2400.1
Letter of Promulgation
1. NAVAL TELECOMMUNICATIONS PROCEDURES (NTP 6(E)), ELECTROMAGNETIC SPECTRUM (EMS) GUIDE was developed under the direction of the Commander, Navy Cyber Forces, and is promulgated for U.S. Navy, Marine Corps, and Coast Guard activities when operating under U.S. Navy Authority. NTP 6(E) updates the information formerly contained in NTP 6(D) and provides guidance and assistance to acquisition, program managers, system development, and operational spectrum management personnel in the conduct of their duties.
2. This guide has been completely revised and should be read in its entirety.
3. NTP 6(E) is an UNCLASSIFIED, non-registered publication.
4. NTP 6(E) is EFFECTIVE UPON RECEIPT and supersedes NTP 6(D).
5. Permission is granted to copy or make extracts from this publication without the consent of the Commander, Navy Cyber Forces.
6. This publication, or extracts thereof, may be carried in aircraft for use therein.
7. Correspondence concerning this publication should be addressed via the normal military chain-of-command to Commander, Navy Cyber Forces N45, 2465 Guadalcanal Road, Suite 10, Virginia Beach, VA 23459-3243.
8. This guide will be reviewed at a minimum of every three (3) years.
THOMAS P. MEEK
Rear Admiral, U.S. Navy
Commander, Navy Cyber Forces

Mission Focused Force

EMSU RM Objective 4.4: Implement Navy E3/Spectrum Awareness training into the Defense Acquisition Workforce Improvement Act (DAWIA) certification process.

- **Joint Training**
  - **Spectrum Professional Develop Plan (SPDP)**
  - **Agency Mission Essential Tasks (AMETs)**
    - **AMETL 5.1: Perform SM & Recommend Policy to support DOD Global Spectrum Access**
    - **AMETL 5.2: Perform analyses & evaluations to support DOD Global Spectrum Access**
    - **AMETL 5.3: Provide SS planning and policy development for DOD**
    - **AMETL 5.4: Conduct evaluations of emerging spectrum technologies**
    - **AMETL 5.5: Provide Operational SM and frequency deconfliction**
    - **AMETL 5.6: Develop, maintain, and make available an operational Joint SM system and supporting spectrum engineering data for combat operations**

- **Navy Training**
  - **E3/SM Navy Training System Plan (NTSP) (J) (N2N6-NTSP-S-70-8003J)**
  - **Navy Mission Essential Tasks**
    - **NTA 5.5.6.2 Assess E3 (Acquisition & Engineering)**
    - **NTA 5.5.6.1 Control EMI (Operational)**
    - **NTA 5.5.6 Perform SM (Operational)**
  - **Acquisition Course Topics (Live on NKO-NeL)**
    - **SPAWAR-SSRA-AP-1.0: Spectrum Supportability Risk Assessment (SSRA) for Acquisitions Personnel**
    - **SPAWAR-E3SO-1.0: Basic Electromagnetic Environmental Effects (E3) Safety Overview**
    - **SPAWAR-BEWO-1.0: Basic Electromagnetic Waves Overview**
    - **SPAWAR-BAO-1.0: Basic Antennas Overview**
    - **SPAWAR-BGBO-1.0: Basic Grounding and Bonding Overview**
    - **SPAWAR-AGT-1.0: Advanced Grounding Theory**
    - **SPAWAR-AST-1.0: Advanced Shielding Theory**
    - **SPAWAR-ADSHS-1.0: Advanced Shielding Solutions**

DoDD 1322.18, Develop and integrate doctrine, organization, training, material, leadership, personnel, and facilities improvements into the joint training environment. Document joint training operations, systems, and technical architectures and certify joint training courses.

CJCS Guide 3501, Mission Focus. Commanders and CSA directors will ensure their training programs are focused on their mission-essential tasks (METs). A successful training program can be achieved when commanders and agency directors consciously focus their training efforts on a prioritized set of training

CFFCINST 3501.3, NMETLs are mission performance requirements which form the basis for the Requirements Phase of the NWTS. NMETL development continues to evolve across the range of military operations and for emerging missions. CRAs will propose NMETLs to USFF for approval. New or refined OPLANs, Concept Plans (CONPLANs), Execution Orders (EXORDs), CCDR RFF/RFC, and Joint Capabilities Areas (JCA) serve as potential sources for new NMETLs.

Action Item 4.4.1: Develop E3/Spectrum Training Tailored to the Acquisition Community

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N@VY KNOWLEDGE ONLINE

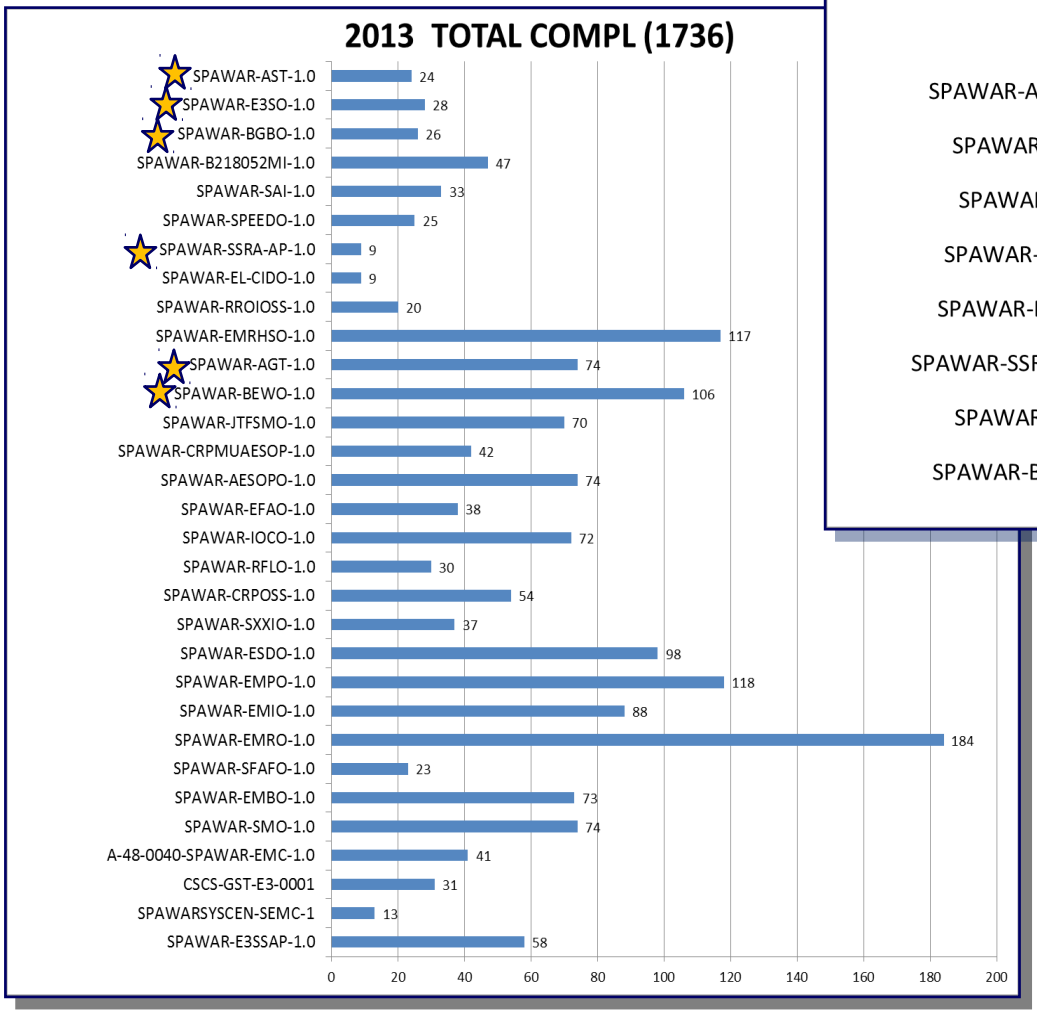
https://wwwa.nko.navy.mil/

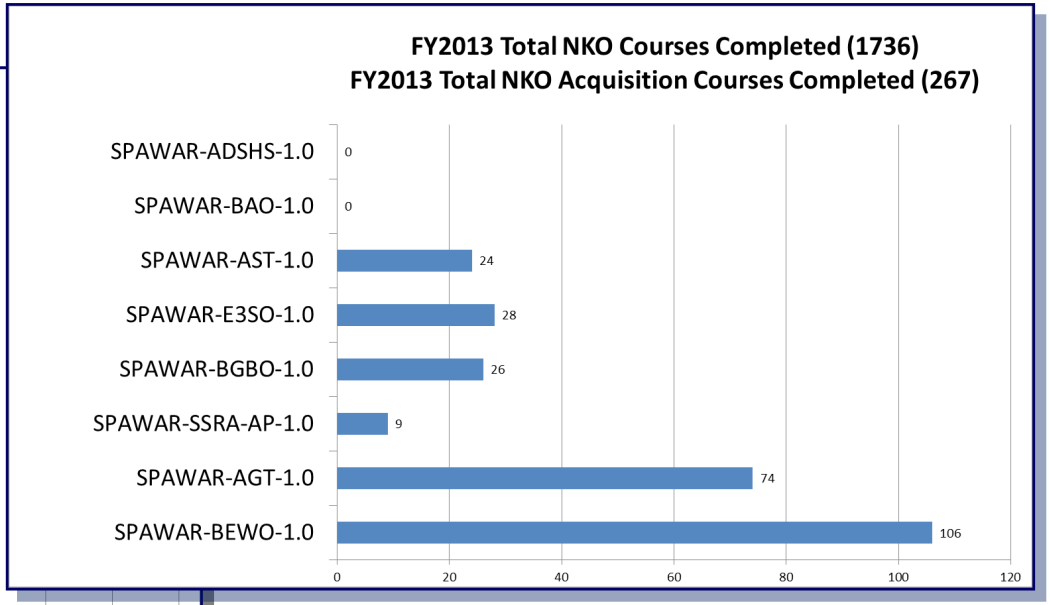
U.S. Navy Acquisition Skill Groups

Advanced E3SS Training (Adv E3SS) 2 Duties, 5 Tasks, Lessons, and Learning Objectives	**SPDP Senior Level Training**
Intermediate E3SS Training (IM E3SS) 2 Duties, 7 Tasks, Lessons, and Learning Objectives	**SPDP Intermediate Level Training**
Basic E3/SS Training (Basic E3/SS) 2 Duties, 27 Tasks, Lessons, and Learning Objectives 8 Lessons on NKO NeL	**SPDP Entry Level Training**

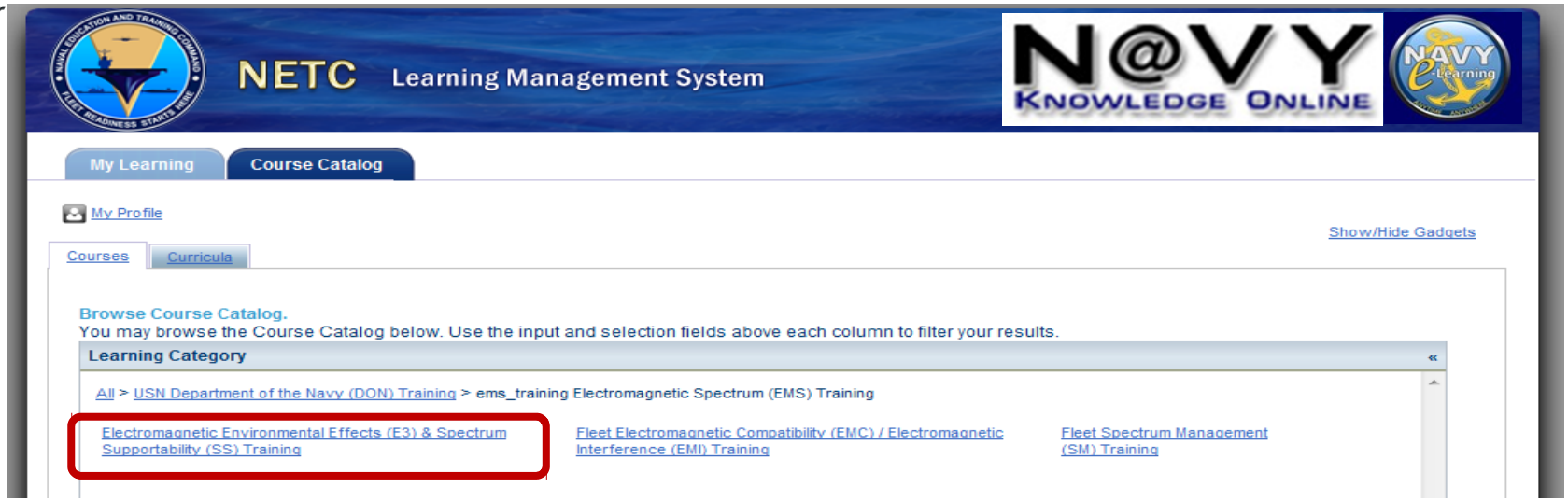
Navy E3/SS Training Summary for: Navy Knowledge Online – Navy eLearning (NKO-NeL)

Systems Center ATLANTIC





Access to Navy E3/SS Acquisition Courses on Navy NKO-NeL


NETC Learning Management System
N@VY KNOWLEDGE ONLINE
My Learning
Course Catalog
My Profile
Show/Hide Gadgets
Courses
Curricula
Browse Course Catalog.
You may browse the Course Catalog below. Use the input and selection fields above each column to filter your results.
Learning Category
All > USN Department of the Navy (DON) Training > ems_training Electromagnetic Spectrum (EMS) Training
Electromagnetic Environmental Effects (E3) & Spectrum Supportability (SS) Training
Fleet Electromagnetic Compatibility (EMC) / Electromagnetic Interference (EMI) Training
Fleet Spectrum Management (SM) Training

- **SPAWAR-SSRA-AP-1.0: Spectrum Supportability Risk Assessment (SSRA) for Acquisitions Personnel**
- **SPAWAR-E3SO-1.0: Basic Electromagnetic Environmental Effects (E3) Safety Overview**
- **SPAWAR-BEWO-1.0: Basic Electromagnetic Waves Overview**
- **SPAWAR-BAO-1.0: Basic Antennas Overview**
- **SPAWAR-BGBO-1.0: Basic Grounding and Bonding Overview**
- **SPAWAR-AGT-1.0: Advanced Grounding Theory**
- **SPAWAR-AST-1.0: Advanced Shielding Theory**
- **SPAWAR-ADSHS-1.0: Advanced Shielding Solutions**

Access to NeL is provided by first gaining access to the NKO
https://wwwa.nko.navy.mil/
https://www.lms.prod.nel.training.navy.mil/

- From the "Learning" box near the top of the screen, click on:
  - Navy e-Learning >On-line Courses
- From the "Content" box on the left side of the screen, click on:
  - Course Catalog
- From the "Learning Category" box in the center of the screen, click on:
  - "Department of the Navy (DON) Training"
- Click on:
  - Electromagnetic Spectrum (EMS) Training
- Click on the desired subcategory:
  - Electromagnetic Environmental Effects (E3) & Spectrum Supportability (SS) Training
  - Fleet Electromagnetic Compatibility (EMC) / Electromagnetic Interference (EMI) Training
  - Fleet Spectrum Management (SM) Training

ACC Practice Center > Spectrum & E3 Compliance > Service E3 and Spectrum... > US Navy and Marine Corps

SPAWAR Systems Center ATLANTIC

US Navy and Marine Corps

Topic

Conduct a Search | Other Actions

Search

Content & Member Profiles | All Communities

Main View | All Contributions | What's New | Q & A

Long Description

Provides workspace for posting and diseminating electromagnetic environmental effects (E3) and spectrum related resources for the Navy and Marine Corps.

Examples of Navy-Marine Frequency Usage

- Extremely Low Frequency (ELF) is critical to stategic and tactical submarine forces. ELF is used to maintain a worldwide reliable link to the Commander in Chief, Vice President, Secretary of Defense, Chairman of the JCS, and geographic Unified Combatant Commanders.
- Very Low Frequency (VLF) is the backbone of submarine communication links and carries the majority of message traffic and tactical directions from Fleet Commanders.
- High Frequency (HF) provides tactical data links for Battle Groups and other Navy and Marine assets. It is also important for allied and coalition force interoperability
- Very High Frequency (VHF) is used for amphibious/littoral ops, base comm systems, and for bridge-to-bridge, LOS communications. VHF is a critical Navy navigation/communication band that is extensively used by both carrier and shore-based aircraft for air-to-ground comm and ATC. VHF is also used for anti-jamming in ground-to-ground equipment, location reporting devices, frequency hopping systems, and various tactical radio receivers.

JSC E3 Document Library

JSC E3/SS Awareness Training Schedule and Class List

For questions regarding any of the information located in the Spectrum and E3 Compliance SIA, please contact the Joint Spectrum Center at: disa.annapolis.dso.list.jsc-j5-training@mail.mil

Request Link Update (Links included on Notes Page):

- NKO – Navy Knowledge Online
- NKO – Electromagnetic Compatibility (EMC) Community of Practice
- NKO – Spectrum Management (SM) Community of Practice
- Shipboard Electromagnetic Capability Improvement Program
- Department of the Navy Strategic Vision for Spectrum
- SECNAVIST 5000.2E - Department of the Navy Implementation and Operation of the Defense Acquisition System and the Joint Capabilities Integration and Development System
- 2400.20F Electromagnetic Environmental Effects and Spectrum Supportability Policy and Procedures

Helpful	Title	Type	Contributor	Date Modified	Popularity
1	NKO - Navy Knowledge Online	Announcement	Private	2013-8-6	14
3	Shipboard Electromagnetic Compatibility Improvement Program (SEMCIP)	Related Websites	Private	2013-6-17	35
2	Navy-Marine Corps Spectrum Center (NMSC) and Navy and Marine Corps Spectrum Offices (NMCSOs)	Related Websites	Private	2013-2-25	68
1	Department of the Navy Strategic Vision for Spectrum	References	Private	2012-6-25	238
1	Official Navy Spectrum Page	Related Websites	Private	2012-6-25	283
1	OPNAVINST 2400.20E - Navy Management of the RF Spectrum	Regulatory	Private	2012-6-25	239
1	OPNAVINST 2450.2 - Navy Electromagnetic Compatibility Program	Regulatory	Private	2012-6-25	128
1	SECNAVIST 5000.2B - Mandatory Procedures for Navy Acquistions	Regulatory	Private	2012-6-25	129

Additional Information for ACC Site: U.S. Navy and Marine Corps Page

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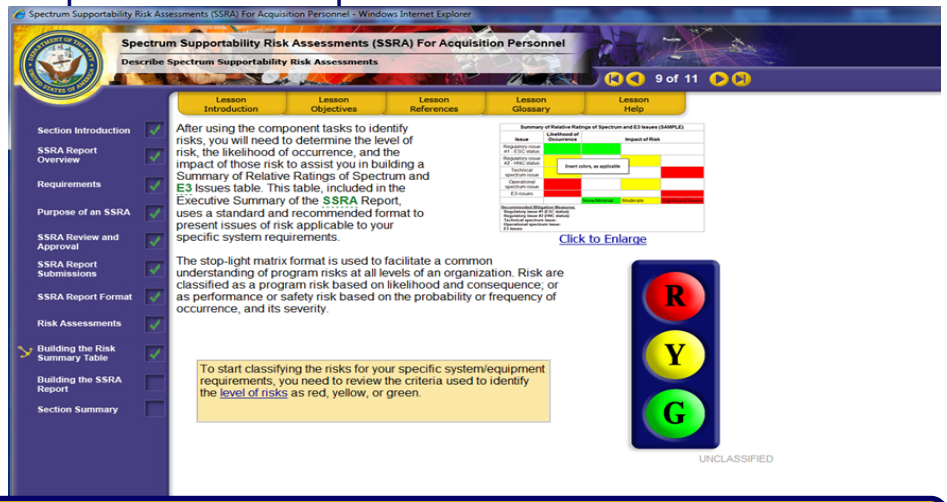
Acquisition Community Connection
Where the DoD AT&L Workforce Meets to Share Knowledge

- **These courses support Joint Spectrum Professional Development Plan (SPDP) Agency Mission Essential Task requirements for Entry Level Training:**
  - SPAWAR-SSRA-AP-1.0: Spectrum Supportability Risk Assessment (SSRA) for Acquisitions Personnel
  - SPAWAR-E3SO-1.0: Basic Electromagnetic Environmental Effects (E3) Safety Overview
  - SPAWAR-BEWO-1.0: Basic Electromagnetic Waves Overview
  - SPAWAR-BAO-1.0: Basic Antennas Overview
  - SPAWAR-BGBO-1.0: Basic Grounding and Bonding Overview
  - SPAWAR-AGT-1.0: Advanced Grounding Theory
  - SPAWAR-AST-1.0: Advanced Shielding Theory
  - SPAWAR-ADSHS-1.0: Advanced Shielding Solutions

- **Course Identification Number (CIN): SPAWAR-SSRA-AP-1.0, Spectrum Supportability Risk Assessment (SSRA) for Acquisitions Personnel**
  - This course presents in-depth instruction on how to prepare an SSRA Report as required by OPNAV 2400.00 (series). The course covers the requirements in DI-EMCS-81543 and the guidance provided in the DoDI 4650.01 and the Final Joint Services Guide for Development of a SSRA. Topics include the SSRA purpose and scope, policy and guidance, defining and classifying risk, and SSRA entry points into the DAS process required for S-D equipment and system. Sample SSRAs are provided.
  - DI-EMCS-81543, SPECTRUM SUPPORTABILITY RISK ASSESSMENT (SSRA); DoD Instruction 4650.01, Policy and Procedures for Management and Use of the Electromagnetic Spectrum; and Joint Services Guide For Development Of A Spectrum Supportability Risk Assessment (SSRA)


Spectrum Supportability Risk Assessments (SSRA) For Acquisition Personnel
Describe Spectrum Supportability Risk Assessments
9 of 11
Lesson Introduction
Lesson Objectives
Lesson References
Lesson Glossary
Lesson Help
Section Introduction
SSRA Report Overview
Requirements
Purpose of an SSRA
SSRA Review and Approval
SSRA Report Submissions
SSRA Report Format
Risk Assessments
Building the Risk Summary Table
Building the SSRA Report
Section Summary
After using the component tasks to identify risks, you will need to determine the level of risk, the likelihood of occurrence, and the impact of those risk to assist you in building a Summary of Relative Ratings of Spectrum and E3 Issues table. This table, included in the Executive Summary of the SSRA Report, uses a standard and recommended format to present issues of risk applicable to your specific system requirements.
Click to Enlarge
The stop-light matrix format is used to facilitate a common understanding of program risks at all levels of an organization. Risk are classified as a program risk based on likelihood and consequence; or as performance or safety risk based on the probability or frequency of occurrence, and its severity.
To start classifying the risks for your specific system/equipment requirements, you need to review the criteria used to identify the level of risks as red, yellow, or green.
R
Y
G
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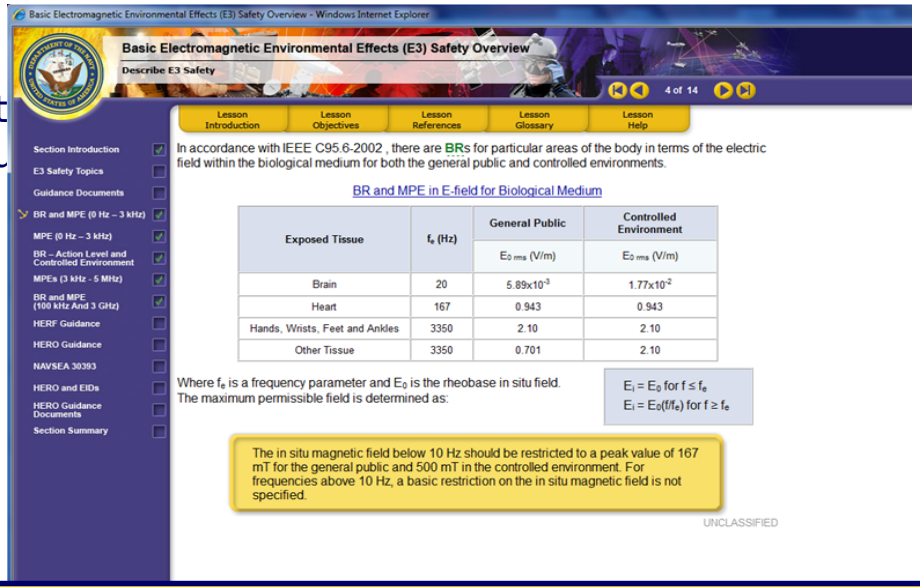
Acquisition Community Connection
Where the DoD AT&L Workforce Meets to Share Knowledge

- **CIN: SPAWAR-E3SO-1.0, Basic Electromagnetic Environmental Effects (E3) Safety Overview**
  - This is a basic course on RADHAZ safety from an E3/SS perspective. It presents general engineering principles and is intended for entry-level E3/SS personnel. The ambient EME can adversely affect personnel, fuels, and ordnance. Primary EME contributors are manmade emitters that can be intentional or unintentional, friendly or hostile. This course addresses the E3 control strategy, including identifying and describing major document and reference material, and provides instru on the basic restrictions and maximum permissible exposure levels and various methods for controlling RADHAZ.


Basic Electromagnetic Environmental Effects (E3) Safety Overview - Windows Internet Explorer
Basic Electromagnetic Environmental Effects (E3) Safety Overview
Describe E3 Safety
4 of 14
Lesson Introduction | Lesson Objectives | Lesson References | Lesson Glossary | Lesson Help
Section Introduction
E3 Safety Topics
Guidance Documents
BR and MPE (0 Hz – 3 kHz)
MPE (0 Hz – 3 kHz)
BR – Action Level and Controlled Environment
MPEs (3 kHz - 5 MHz)
BR and MPE (100 kHz And 3 GHz)
HERF Guidance
HERO Guidance
NAVSEA 30393
HERO and EIDs
HERO Guidance Documents
Section Summary
In accordance with IEEE C95.6-2002 , there are BRs for particular areas of the body in terms of the electric field within the biological medium for both the general public and controlled environments.
BR and MPE in E-field for Biological Medium
Exposed Tissue | fe (Hz) | General Public E0 rms (V/m) | Controlled Environment E0 rms (V/m)
Brain | 20 | 5.89x10-3 | 1.77x10-2
Heart | 167 | 0.943 | 0.943
Hands, Wrists, Feet and Ankles | 3350 | 2.10 | 2.10
Other Tissue | 3350 | 0.701 | 2.10
Where fe is a frequency parameter and E0 is the rheobase in situ field.
The maximum permissible field is determined as:
Ei = E0 for f ≤ fe
Ei = E0(f/fe) for f ≥ fe
The in situ magnetic field below 10 Hz should be restricted to a peak value of 167 mT for the general public and 500 mT in the controlled environment. For frequencies above 10 Hz, a basic restriction on the in situ magnetic field is not specified.
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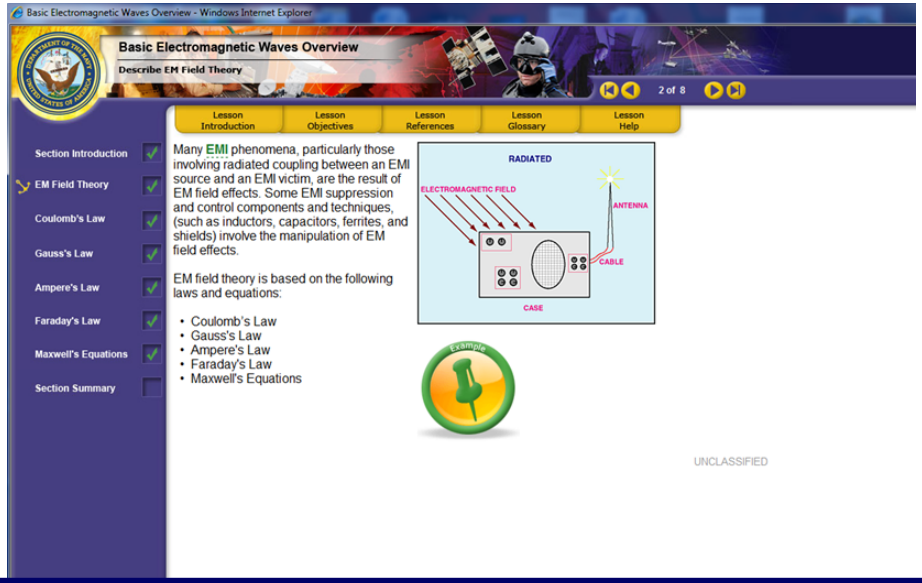
Acquisition Community Connection
Where the DoD AT&L Workforce Meets to Share Knowledge

- **CIN: SPAWAR-BEWO-1.0, Basic Electromagnetic Waves Overview**
  - This is a basic course on electromagnetic waves. It presents general engineering principles and is intended for entry-level E3/SS personnel. Many EMI phenomena, particularly those involving radiated coupling between an EMI source and an EMI victim, are the result of EM field effects. This course addresses the properties of EM fields, including the theory, laws, and equations behind them.
    In depth instruction is provided on the properties and behaviors of near and far fields. The theory of EM waves is presented, including plane waves, wave impedance, power density and field intensities, wave velocity, frequency and wavelength, and polarization.


Basic Electromagnetic Waves Overview - Windows Internet Explorer
Basic Electromagnetic Waves Overview
Describe EM Field Theory
2 of 8
Lesson Introduction
Lesson Objectives
Lesson References
Lesson Glossary
Lesson Help
Section Introduction
EM Field Theory
Coulomb's Law
Gauss's Law
Ampere's Law
Faraday's Law
Maxwell's Equations
Section Summary
Many EMI phenomena, particularly those involving radiated coupling between an EMI source and an EMI victim, are the result of EM field effects. Some EMI suppression and control components and techniques, (such as inductors, capacitors, ferrites, and shields) involve the manipulation of EM field effects.
EM field theory is based on the following laws and equations:
• Coulomb's Law
• Gauss's Law
• Ampere's Law
• Faraday's Law
• Maxwell's Equations
RADIATED
ELECTROMAGNETIC FIELD
ANTENNA
CABLE
CASE
Example
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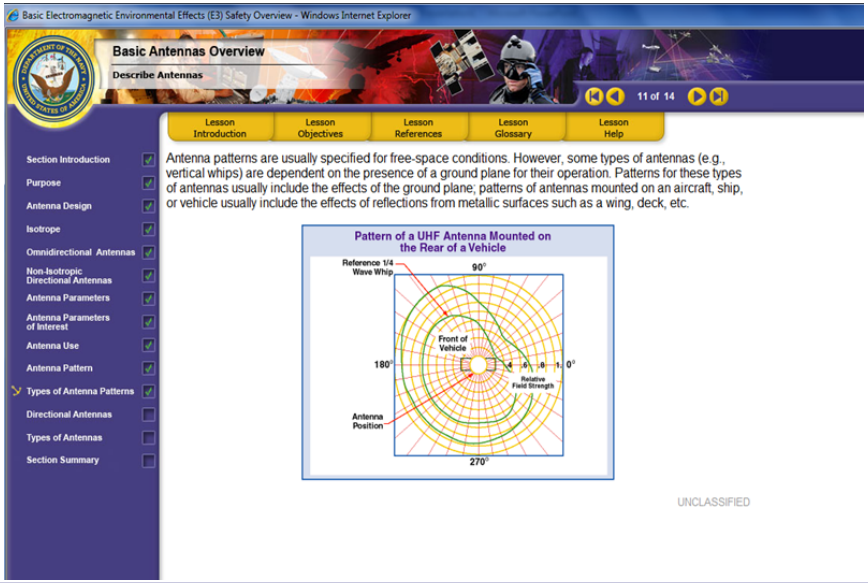
Acquisition Community Connection
Where the DoD AT&L Workforce Meets to Share Knowledge

- **CIN: SPAWAR-BAO-1.0, Basic Antennas Overview**
  - This is a basic course on antennas. It presents general engineering principles and is intended for entry-level E3/SS personnel. An antenna is the system component that is designed to radiate or receive EM waves. This course addresses the general principles behind isotropic, non-isotropic, directional, and omnidirectional antennas. It covers all of the various types of antennas, including monopole and half-wave dipole. The following characteristics are discussed: bandwidth, beam width, directivity, gain, minor lobe level, polarization, input impedance, radiation resistance, and receiving cross section. This course also provides an overview of the radiation and reception characteristics of an antenna and their importance from an EMC perspective.


Basic Electromagnetic Environmental Effects (E3) Safety Overview - Windows Internet Explorer
Basic Antennas Overview
Describe Antennas
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Lesson Introduction
Lesson Objectives
Lesson References
Lesson Glossary
Lesson Help
Section Introduction
Purpose
Antenna Design
Isotrope
Omnidirectional Antennas
Non-Isotropic Directional Antennas
Antenna Parameters
Antenna Parameters of Interest
Antenna Use
Antenna Pattern
Types of Antenna Patterns
Directional Antennas
Types of Antennas
Section Summary
Antenna patterns are usually specified for free-space conditions. However, some types of antennas (e.g., vertical whips) are dependent on the presence of a ground plane for their operation. Patterns for these types of antennas usually include the effects of the ground plane; patterns of antennas mounted on an aircraft, ship, or vehicle usually include the effects of reflections from metallic surfaces such as a wing, deck, etc.
Pattern of a UHF Antenna Mounted on the Rear of a Vehicle
Reference 1/4 Wave Whip
90°
180°
270°
Front of Vehicle
Relative Field Strength
Antenna Position
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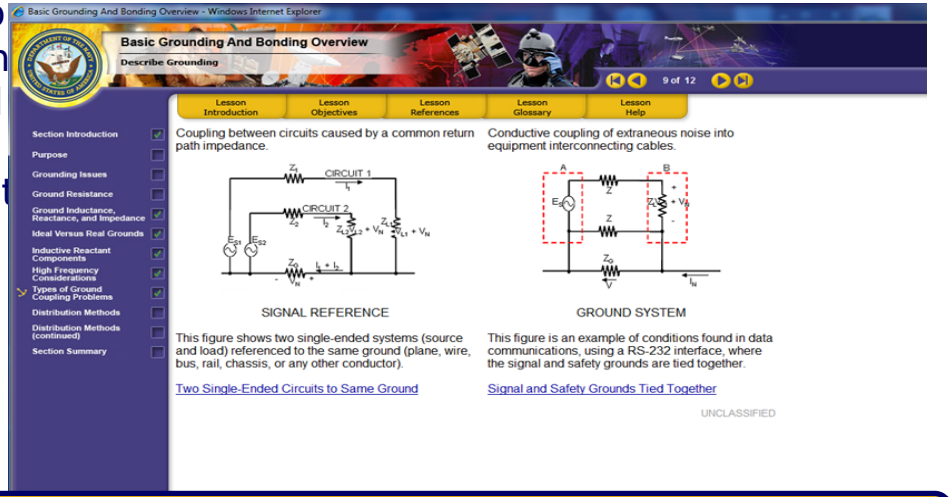
Acquisition Community Connection
Where the DoD AT&L Workforce Meets to Share Knowledge

- **CIN: SPAWAR-BGBO-1.0, Basic Grounding and Bonding Overview**
  - This is a basic course on grounding and bonding. It presents general engineering principles and is intended for entry-level E3/SS personnel. Grounding for minimization of EMI is one of the more problematic topics of the EMC engineering field. This course addresses grounding issues such as resistance; ground inductance, reactance, and impedance; ideal versus real grounds; distribution methods; etc. In depth attention is given to signal grounds, grounding problems, and grounding solutions. Often, the EMC deterioration of equipment and systems over their lifetime is linked directly to the degradatio of bonding characteristics due to corrosion mechanical stress, or other environmental reasons. This course delves into the types of bonds and the EMI effects on equipment and systems when poor bonding is performed.


Basic Grounding And Bonding Overview - Windows Internet Explorer
Basic Grounding And Bonding Overview
Describe Grounding
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Lesson Introduction
Lesson Objectives
Lesson References
Lesson Glossary
Lesson Help
Section Introduction
Purpose
Grounding Issues
Ground Resistance
Ground Inductance, Reactance, and Impedance
Ideal Versus Real Grounds
Inductive Reactant Components
High Frequency Considerations
Types of Ground Coupling Problems
Distribution Methods
Distribution Methods (continued)
Section Summary
Coupling between circuits caused by a common return path impedance.
Conductive coupling of extraneous noise into equipment interconnecting cables.
CIRCUIT 1
CIRCUIT 2
SIGNAL REFERENCE
GROUND SYSTEM
This figure shows two single-ended systems (source and load) referenced to the same ground (plane, wire, bus, rail, chassis, or any other conductor).
This figure is an example of conditions found in data communications, using a RS-232 interface, where the signal and safety grounds are tied together.
Two Single-Ended Circuits to Same Ground
Signal and Safety Grounds Tied Together
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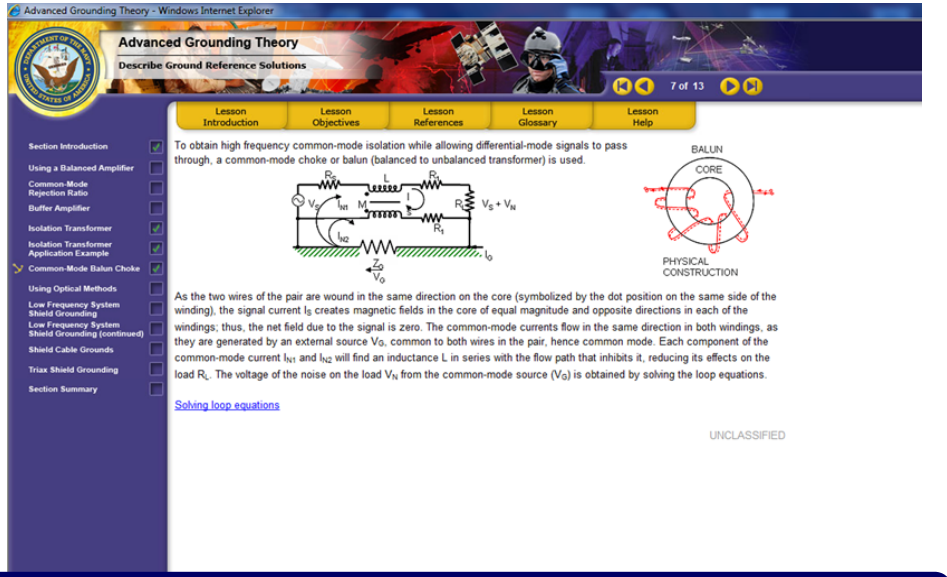
Acquisition Community Connection
Where the DoD AT&L Workforce Meets to Share Knowledge

- **CIN: SPAWAR-AGT-1.0, Advanced Grounding Theory**
  - This course presents advanced engineering concepts related to grounding theory. It is intended for E3/SS personnel who already possess a solid understanding of basic E3/SS. It focuses on protecting systems and equipment from the effects of exposure to EMI through grounding, specifically solutions designed to eliminate the ground as reference by transporting the signal by means of a balanced path in which the signal path carries its own reference. It analyzes the various methods and techniques of grounding when given the many uncontrolled factors that affect the performance of grounding solutions.


Advanced Grounding Theory - Windows Internet Explorer
Advanced Grounding Theory
Describe Ground Reference Solutions
7 of 13
Lesson Introduction
Lesson Objectives
Lesson References
Lesson Glossary
Lesson Help
Section Introduction
Using a Balanced Amplifier
Common-Mode Rejection Ratio
Buffer Amplifier
Isolation Transformer
Isolation Transformer Application Example
Common-Mode Balun Choke
Using Optical Methods
Low Frequency System Shield Grounding
Low Frequency System Shield Grounding (continued)
Shield Cable Grounds
Triax Shield Grounding
Section Summary
To obtain high frequency common-mode isolation while allowing differential-mode signals to pass through, a common-mode choke or balun (balanced to unbalanced transformer) is used.
BALUN
CORE
PHYSICAL CONSTRUCTION
As the two wires of the pair are wound in the same direction on the core (symbolized by the dot position on the same side of the winding), the signal current I_S creates magnetic fields in the core of equal magnitude and opposite directions in each of the windings; thus, the net field due to the signal is zero. The common-mode currents flow in the same direction in both windings, as they are generated by an external source V_O, common to both wires in the pair, hence common mode. Each component of the common-mode current I_{N1} and I_{N2} will find an inductance L in series with the flow path that inhibits it, reducing its effects on the load R_L. The voltage of the noise on the load V_N from the common-mode source (V_O) is obtained by solving the loop equations.
Solving loop equations
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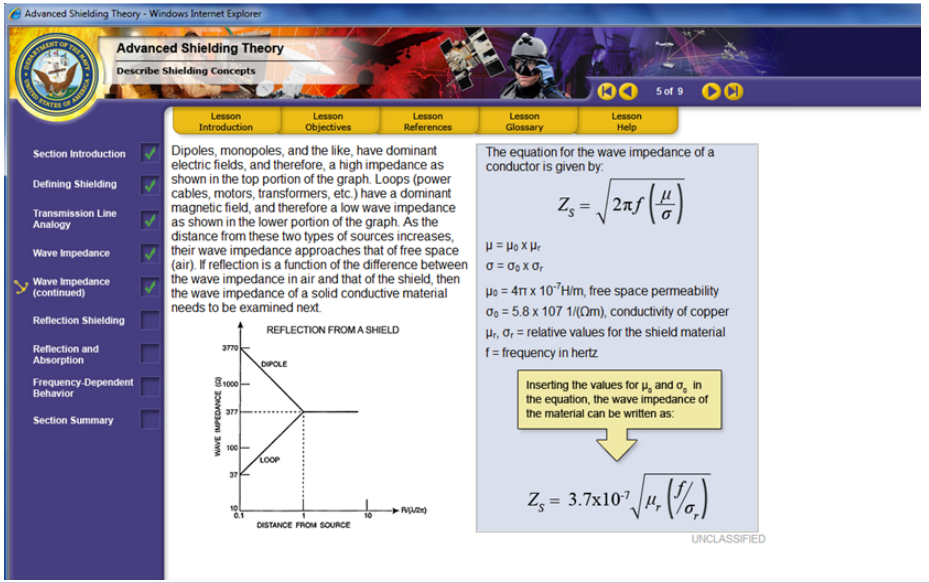
Acquisition Community Connection
Where the DoD AT&L Workforce Meets to Share Knowledge

- **CIN: SPAWAR-AST-1.0, Advanced Shielding Theory**
  - This course presents advanced engineering concepts related to shielding theory. It is intended for E3/SS personnel who already possess a solid understanding of basic E3/SS. This course focuses on protecting systems and equipment from the effects of exposure to EMI through shielding; including the concept of shielding theory and how shields can control radiated EMI, shielding effectiveness, and the performance of shielding materials. Topics include wave impedance, the properties of materials as they relate to reflection and absorption losses, and frequency-dependent behavior. An in-depth instruction on magnetic shielding, its properties and effectiveness, is included.


Advanced Shielding Theory - Windows Internet Explorer
Advanced Shielding Theory
Describe Shielding Concepts
5 of 9
Lesson Introduction
Lesson Objectives
Lesson References
Lesson Glossary
Lesson Help
Section Introduction
Defining Shielding
Transmission Line Analogy
Wave Impedance
Wave Impedance (continued)
Reflection Shielding
Reflection and Absorption
Frequency-Dependent Behavior
Section Summary
Dipoles, monopoles, and the like, have dominant electric fields, and therefore, a high impedance as shown in the top portion of the graph. Loops (power cables, motors, transformers, etc.) have a dominant magnetic field, and therefore a low wave impedance as shown in the lower portion of the graph. As the distance from these two types of sources increases, their wave impedance approaches that of free space (air). If reflection is a function of the difference between the wave impedance in air and that of the shield, then the wave impedance of a solid conductive material needs to be examined next.
REFLECTION FROM A SHIELD
DIPOLE
LOOP
WAVE IMPEDANCE (Ω)
DISTANCE FROM SOURCE
The equation for the wave impedance of a conductor is given by:
$Z_S = \sqrt{2\pi f \left(\frac{\mu}{\sigma}\right)}$
$\mu = \mu_0 \times \mu_r$
$\sigma = \sigma_0 \times \sigma_r$
$\mu_0 = 4\pi \times 10^{-7}$ H/m, free space permeability
$\sigma_0 = 5.8 \times 107$ 1/(Ωm), conductivity of copper
μ_r, σ_r = relative values for the shield material
f = frequency in hertz
Inserting the values for μ_r and σ_0 in the equation, the wave impedance of the material can be written as:
$Z_S = 3.7\text{x}10^{-7}\sqrt{\mu_r \left(\frac{f}{\sigma_r}\right)}$
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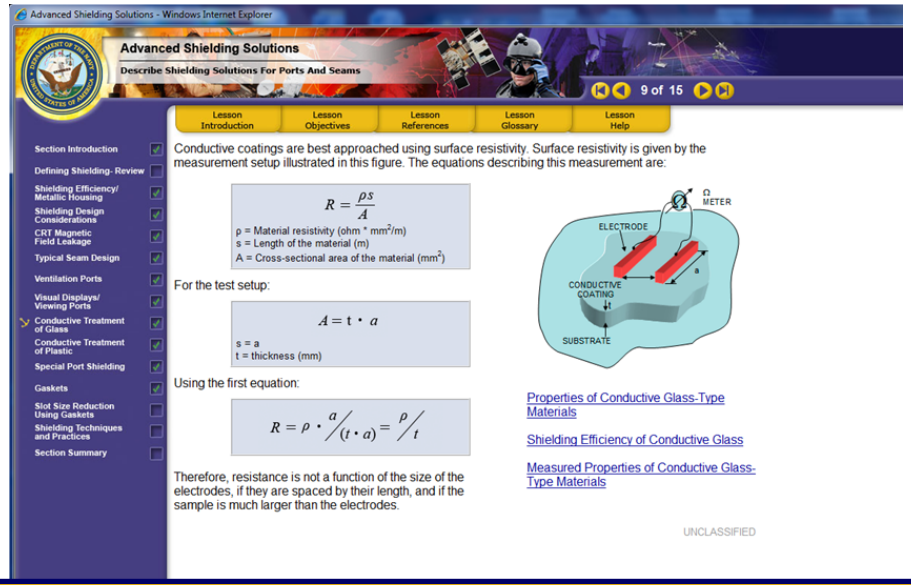
Acquisition Community Connection
Where the DoD AT&L Workforce Meets to Share Knowledge

- **CIN: SPAWAR-ADSHS-1.0, Advanced Shielding Solutions**
  - This course presents advanced engineering principles related to shielding solutions. It is intended for E3/SS personnel who already possess a solid understanding of basic E3/SS. Shielding can help reduce or prevent the effects of EMI on sensitive electronic/electromagnetic equipment. This course addresses shielding solutions for ports, displays, and housings of various types of equipment and systems. It includes discussions of the shielding properties of various materials and addresses engineering concepts such as the Faraday Cage Concept. In depth attention is paid to the specific requirements and considerations of cable shielding.


Advanced Shielding Solutions - Windows Internet Explorer
Advanced Shielding Solutions
Describe Shielding Solutions For Ports And Seams
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Lesson Introduction
Lesson Objectives
Lesson References
Lesson Glossary
Lesson Help
Section Introduction
Defining Shielding- Review
Shielding Efficiency/ Metallic Housing
Shielding Design Considerations
CRT Magnetic Field Leakage
Typical Seam Design
Ventilation Ports
Visual Displays/ Viewing Ports
Conductive Treatment of Glass
Conductive Treatment of Plastic
Special Port Shielding
Gaskets
Slot Size Reduction Using Gaskets
Shielding Techniques and Practices
Section Summary
Conductive coatings are best approached using surface resistivity. Surface resistivity is given by the measurement setup illustrated in this figure. The equations describing this measurement are:
$R = \frac{\rho s}{A}$
ρ = Material resistivity (ohm * mm²/m)
s = Length of the material (m)
A = Cross-sectional area of the material (mm²)
For the test setup:
$A = t \cdot a$
s = a
t = thickness (mm)
Using the first equation:
$R = \rho \cdot \frac{a}{(t \cdot a)} = \frac{\rho}{t}$
Therefore, resistance is not a function of the size of the electrodes, if they are spaced by their length, and if the sample is much larger than the electrodes.
Ω METER
ELECTRODE
CONDUCTIVE COATING
SUBSTRATE
Properties of Conductive Glass-Type Materials
Shielding Efficiency of Conductive Glass
Measured Properties of Conductive Glass-Type Materials
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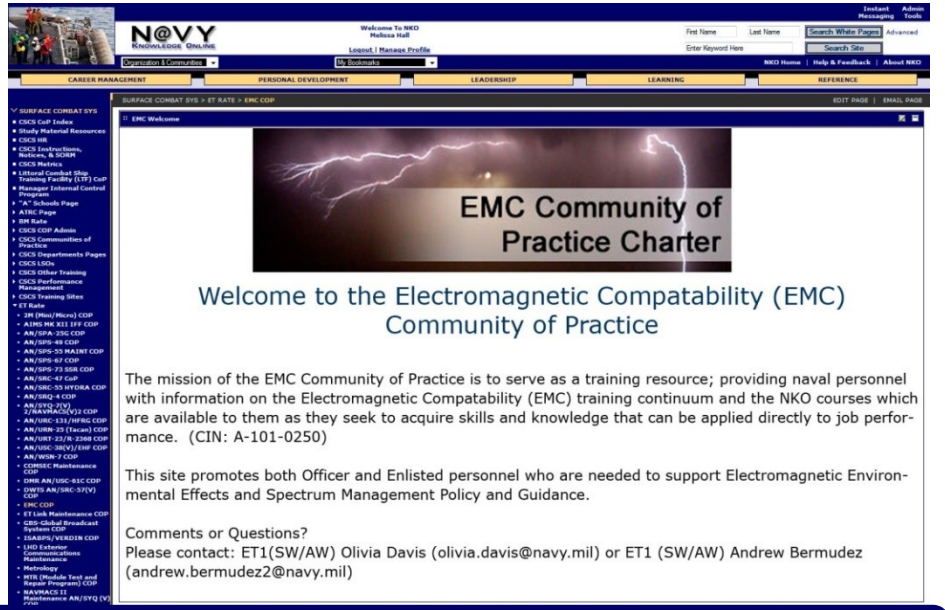
EMC Community Of Practice (COP)

- **SPAWAR-Atlantic is tasked with maintaining the Electromagnetic Compatibility (EMC) Community of Practice (CoP) sites on NKO. The EMC CoP focuses on providing Navy EMC personnel with continuous learning, mutual exchange, and collaboration. The EMC CoP is sponsored by the Center for Surface Combat Systems (CSCS). This site has as its primary mission providing support for the Installation and Afloat Spectrum Managers and the NEC ET-1419 "EMC Technician."**
- **The EMC CoP site provides a variety of information including: Navigation links to the Electromagnetic Spectrum Usage (EMSU) Roadmap Drumbeat Meetings, Deliverables, and Key Presentations; Information on specialized E3/SS and EMC training, including classroom, distance learning via NeL, DVDs, briefings, etc. along with locations and points of contact; a calendar of events; EMC message board; etc.**

NKO: https://wwwa.nko.navy.mil/portal/surfacecombatsys/etcop/home/emccop


N@VY
CAREER MANAGEMENT
PERSONAL DEVELOPMENT
LEADERSHIP
LEARNING
REFERENCE
EMC Community of Practice Charter
Welcome to the Electromagnetic Compatability (EMC) Community of Practice
The mission of the EMC Community of Practice is to serve as a training resource; providing naval personnel with information on the Electromagnetic Compatability (EMC) training continuum and the NKO courses which are available to them as they seek to acquire skills and knowledge that can be applied directly to job performance. (CIN: A-101-0250)
This site promotes both Officer and Enlisted personnel who are needed to support Electromagnetic Environmental Effects and Spectrum Management Policy and Guidance.
Comments or Questions?
Please contact: ET1(SW/AW) Olivia Davis (olivia.davis@navy.mil) or ET1 (SW/AW) Andrew Bermudez (andrew.bermudez2@navy.mil)

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SM Community Of Practice (COP)

- **SPAWAR-Atlantic is tasked with maintaining the Spectrum Management (SM) Communities of Practice (CoP). The SM CoP focuses on providing Navy SM personnel with continuous learning, mutual exchange, and collaboration. The SM CoP is sponsored by the Center for Information Dominance (CID). The primary mission of this site is to provide support to the NEC IT-2301 "Enlisted Frequency Manager" and the NEC IT-2302 "Joint Task Force (JTF) Spectrum Management Master Level."**
- **The SM CoP site provides a variety of information including: Navigation links to the Electromagnetic Spectrum Usage (EMSU) Roadmap Drumbeat Meetings, Deliverables, and Key Presentations; Information on specialized E3/SS and SM training, including classroom, distance learning via NeL, DVDs, briefings, etc. along with locations and points of contact; etc.**

NKO: https://wwwa.nko.navy.mil/portal/cid/it/smcop/home

N@VY
Welcome To NKO
Logout | Manage Profile
CAREER MANAGEMENT
PERSONAL DEVELOPMENT
LEADERSHIP
LEARNING
REFERENCE
Spectrum Management Welcome
Welcome to the Spectrum Management Community of Practice
The mission of the Spectrum Management (SM) Community of Practice (CoP) is to serve as a training resource; providing naval personnel with information on the spectrum management training continum and the NKO courses which are available to them as they sek to acquire skills and knowledge that can be applied directly to job performance.
This site promotes both Officer and Enlisted personnel who are needed to support Spectrum Management Policy and Guidance.
Comments or Questions? Please contact: Deems C. Wiggs (deems.wiggs@navy.mil)

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Questions

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SPAWAR
Systems Center
ATLANTIC

Backups

SPAWAR-SSRA-AP-1.0: Spectrum Supportability Risk Assessment (SSRA) for Acquisitions Personnel

- A Spectrum Supportability Risk Assessment (SSRA) is a Summary Report required for S-D equipment/system that identifies its purpose and scope and defines and classifies risk in preparation for submission into the Defense Acquisition System (DAS) process
- **When preparing the SSRA, the focus should be on those risks determined as moderate to high risk areas and presenting mitigation strategies and/or a plan to circumvent those risks.**
- The SSRA is performed by Program Managers (PMs) and Material Developers (MATDEVs) of any program that is acquiring or incorporating S-D systems or equipment. The SSRA identifies and assesses an acquisition's potential to affect the required performance of the newly acquired system or other existing systems within the operational Electromagnetic Environment (EME).

To ensure that all user requirements are met, PM/MATDEVs should consult, as early as possible, with their respective MILDEP SMO regarding the application and tailoring of the SSRA.

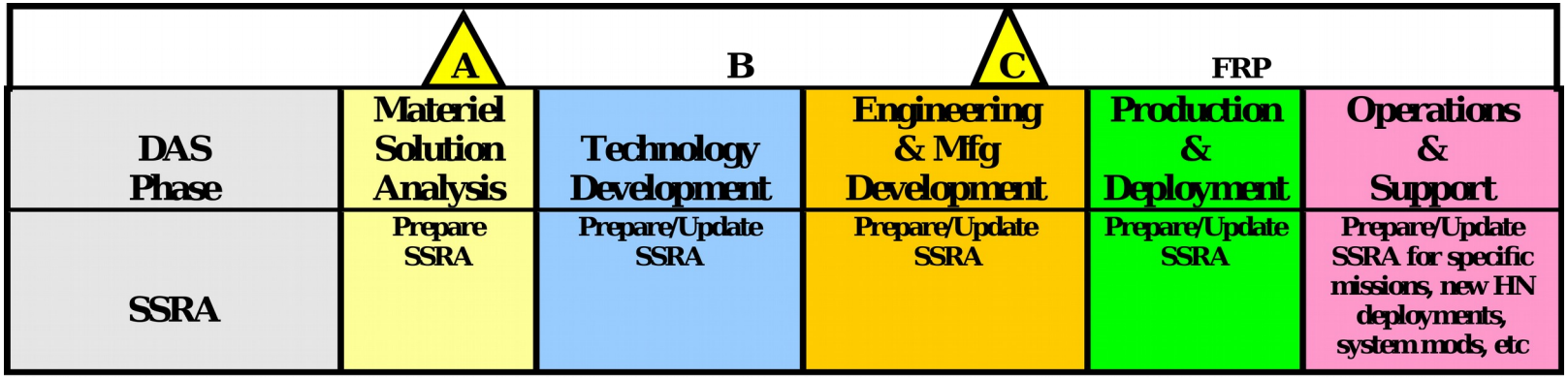
The MILDEP SMO reviews the SSRA, writes recommendations, and forwards these to the Service CIO for approval.

A statement of SS for an acquisition is then forwarded to the MDA.

SPAWAR-SSRA-AP-1.0: Spectrum Supportability Risk Assessment (SSRA) for Acquisitions Personnel (Continued)

- **An SSRA Report provides a formally documented SS risk assessment, with mitigation measure(s) identified,** to achieve a SS determination from the FMO, service CIO, or OSD(NII) (depending on ACAT and/or level of Interest), it presents the following information for an S-D system/equipment: J/F 12's, Status of HN Coordination, Provision/discussion of known SS and E3 issues and assigns RISK, Discussion of potential operational impact of known SS and E3 deficiencies, Provision for program risk (R/Y/G) for each system, a risk summary, mitigation plans to reduce or eliminate YELLOW and RED issues, and Provision for an overall Program assessment for upcoming acquisition Milestones

- An SSRA report is prepared, updated, and submitted for approval to the appropriate Service review authority prior to each acquisition Milestone (MS) and readiness reviews. With each update and submission, the level of detail increases as the item's design matures and as more information becomes available. In general, whenever an acquisition includes or incorporates an S-D system or equipment, including CI and NDI, each PM/MATDEV is required to prepare an SSRA and submit it for approval prior to the deployment.



SPAWAR-SSRA-AP-1.0: Spectrum Supportability Risk Assessment (SSRA) for Acquisitions Personnel (Continued)

- **SSRA Report Items included are:**
  - Name and logo of the PM/MATDEV submitting the SSRA
  - Detailed description of the equipment/system
  - **Summary of Spectrum and E3 Issues in Stop-Light Chart Format**
  - Brief summaries of important aspects of impacts, conclusions as a result of SSRA (formatted in a stop-light chart to display the information), and recommendations

- **The SSRA Report has four main components and suggested tasks that should be completed.**

  - **The Regulatory Component** and tasks address the equipment spectrum certification stage and status, and the acquisition status applicable to the DAS phase of the acquisition. This component also addresses the Host Nation Coordination relative to the radio services authorized within the Table of Allocations of the U.S. and intended Host Nations, and responses in Host-Nation Spectrum Worldwide Database Online from the HNC processes.

  - **The Technical Component** and tasks focus on the candidate technologies and the required technical parameters of the system's components (e.g. receivers, transmitters, antennas). This section of an SSRA should contain a description of the technical parameters and include the results of technical tasks previously conducted.

  - **The Operational Component** and tasks focus on providing a statement of the program requirements, how they are being met, and a description of the intended operational deployment of the system.

  - **The E3 Component** and tasks focuses on performing **E3 Assessments** for DoD components developing or acquiring S-D systems, including Commercial Items (CI) and Non-Developmental Items